Boyana Norris

Mathematics and Computer Science Division
Argonne National Laboratory
Building 221, Room D236
9700 South Cass Avenue
Argonne, IL 60439

Office: (630) 252-7908
Home: (630) 226-0670
Fax: (630) 252-5986
norris@mcs.anl.gov
http://www.mcs.anl.gov/~norris

RESEARCH INTERESTS

Norris conducts research on enabling technologies for high-performance simulations in computational science and engineering, with emphasis on automation of the development, deployment, and performance tuning of parallel applications. Specific research areas include (1) source code analysis and transformation, specifically on automatic differentiation and performance analysis; (2) software engineering approaches for high-performance computing, focusing on numerical components and supporting infrastructure; and (3) software quality of service for scientific components, with an emphasis on adaptive linear solver strategies for the numerical solution of nonlinear partial differential equations.

EDUCATION

Ph.D. in Computer Science, University of Illinois at Urbana-Champaign, Urbana, IL, Jan. 2000.
Thesis Title: "An Environment For Interactive Parallel Numerical Computing"
Thesis Advisor: Professor Michael T. Heath

B.S. in Computer Science, Wake Forest University, Winston-Salem, NC, May 1995.

EMPLOYMENT

Computer Scientist, Argonne National Laboratory, March 2006–present. Design and development of numerical components and related infrastructure; compiler-based tools for automatic differentiation; performance modeling and prediction; power-aware high-performance computing; methods and software for nanophotonics simulation.

Assistant Computer Scientist, Argonne National Laboratory, October 2001–March 2006. High performance scientific component software; automatic differentiation; performance modeling and prediction; computational nanophotonics.

Postdoctoral Research Staff, Argonne National Laboratory, November 1999–October 2001. Development of tools for automatic differentiation and AD integration into numerical software.

Teaching Assistant, University of Illinois at Urbana-Champaign, January–May, 1999. Teaching discussion sections in an introductory computer science course, exam and homework preparation and grading.

Wallace Givens Research Associate, Argonne National Laboratory, Summer 1998. Development of a differentiated version of PETSc using automatic differentiation tools and high-level algorithmic templates.

Graduate Research Assistant to Professor Michael Heath, National Center for Supercomputing Applications, University of Illinois, June 1996–January 1999, August–November 1999. Design and implementation of a Matlab-based high-performance parallel computing environment.

Consultant/Senior Programmer, Liberty Data Systems, Kernersville, NC, summer 1995. Network application development and consulting.

Consultant/Programmer, self-employed, Apr. 1994–May 1995. Business application development and general software and hardware consulting.

Computer Center Consultant, Wake Forest University, Aug. 1994–May 1995. Applications support for university software (Windows, MacOS, Unix).

Software Developer, AMP, Inc., Winston-Salem, NC, summer 1994. MS Windows business application development, mainly relational databases for plant operation and administration.

Consultant/Programmer, Information Technology Professionals, Winston-Salem, NC, Aug. 1993–May 1994. Business application development, including relational databases management applications and custom accounting software.

Undergraduate research assistant to Dr. Michael Heath (REU Program), National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, Jan. 1993–May 1993. Developed and implemented a generalized parallel matrix multiplication algorithm using 2D data partitioning.

HONORS AND AWARDS

- Fellowship recipient at the Second MIT CFD Conference, June 2003.
- Led the design and implementation of the parallel components for partial differential equations and optimization, which were recognized as one of the top 10 DOE Office of Science achievements in 2002 (`http://www.sc.doe.gov/sub/accomplishments/top_10.htm`).
- Excellent Teaching Assistant Award, University of Illinois at Urbana-Champaign, Spring 1999.
- SURGE Graduate Fellowship, University of Illinois at Urbana-Champaign, Sep. 1995–present.
- Carswell Distinguished Scholarship, Wake Forest University, Sep. 1994–May 1995.
- Presidential Scholarship, Southwest State University, Sep. 1991–Dec. 1993.
- Member of the National Honor Society since Jan., 1991; Phi Beta Kappa since Apr., 1994.

EXTERNAL FUNDING

- National Science Foundation, BPC supplement to NSF-funded prooject *Adaptive Software for Extreme-Scale Scientific Computing: Co-Managing Quality-Performance-Power Tradeoffs*, P. Raghavan (Penn. State), M. J. Irwin (Penn. State), L. C. McInnes (ANL), and B. Norris (ANL), approved, October 2006–October 2007.
- National Science Foundation, *Collaborative Research: CMG: Uncertainty Quantification in Geophysical State Estimation*, P. Hovland (University of Chicago), B. Norris (ANL), C. Wunsch (MIT), approximately $723K total, October 2005 – October 2008.
- National Science Foundation, *Adaptive Software for Extreme-Scale Scientific Computing: Co-Managing Quality-Performance-Power Tradeoffs*, P. Raghavan (Penn. State), M. J. Irwin (Penn. State), L. C. McInnes (ANL), and B. Norris (ANL), $750K total, October 2004 – October 2007.
- Department of Energy, *High-End Computer System Performance: Science and Engineering ISIC*, Scientific Discovery through Advanced Computing (SciDAC) Computer Science Integrated Software Infrastructure Center, multi-site project led by David Bailey, $2.4M/year, 2001 – 2004, recompeted for 2004 – 2006.
- Department of Energy, *Computational Nanophotonics: Model Optical Interactions and Transport in Tailored Nanosystem Architectures*, multi-site project led by Stephen Gray, approximately $1.3M/year, August 2003 – August 2008.

PROFESSIONAL ACTIVITIES

- Secretary of SIAM Activity Group on Supercomputin, 2006–present.
- Member: ACM (1998), IEEE Computer Society (1999), SIAM (1998), SIAG/SC (2005).
- Member of the Common Component Architecture Forum since 1999.
- Member of the MCS Library Committee, 2003–2005.
- Reviewer, IPDPS'2001, AD Workshop at ICCSA'03, SAC'03, HICSS (2003, 2004), DOE SBIR grants (2006), DOE Early Career Grants (2003, 2004), IEEE Proceedings (2004), AD'2004, International Journal of Computers and Applications (2005).
- Minisymposia organized: *Performance Evaluation Challenges and Adaptive Numerical Approaches in Scientific Software* at the SIAM Computational Science and Engineering Conference, February 13, 2005; *High Performance Components* at the Eleventh SIAM Conference on Parallel Processing for Scientific Computing (PP04).
- Organizing and program committee member for Fourth International Conference on Automatic Differentiation, AD'2004.
- Organizing committee member for the Workshop on Domain-Specific Languages for Optimization, Argonne National Laboratory, August 18-20, 2004.
- Organizing committee member for the High Performance Computing Workshop at the Computer Science Department, University of Illinois at Urbana-Champaign, 1999.

PUBLICATIONS

Books Edited

[1] H. M. Bücker, G. F. Corliss, P. D. Hovland, U. Naumann, and B. Norris, editors. *Automatic Differentiation: Applications, Theory, and Implementations*, vol. 50. Lecture Notes in Computational Science and Engineering. Springer, New York, NY, 2005.

Refereed Journal Articles and Book Chapters

[2] D. E. Bernholdt, B. A. Allan, R. Armstrong, F. Bertrand, K. Chiu, T. L. Dahlgren, K. Damevski, W. R. Elwasif, T. G. W. Epperly, M. Govindaraju, D. S. Katz, J. A. Kohl, M. Krishnan, G. Kumfert, J. W. Larson, S. Lefantzi, M. J. Lewis, A. D. Malony, L. C. McInnes, J. Nieplocha, B. Norris, S. G. Parker, J. Ray, S. Shende, T. L. Windus, and S. Zhou. A component architecture for high-performance scientific computing. *International Journal of High Performance Computing Applications*, Nov. 2005. To appear in ACTS Collection special issue.

[3] L. C. McInnes, B. A. Allan, R. Armstrong, S. J. Benson, D. E. Bernholdt, T. L. Dahlgren, L. F. Diachin, M. Krishnan, J. A. Kohl, J. W. Larson, S. Lefantzi, J. Nieplocha, B. Norris, S. G. Parker, J. Ray, and S. Zhou. Parallel PDE-based simulations using the Common Component Architecture. Tech. Rep. ANL/MCS-P1179-0704, Argonne National Laboratory, 2005. To appear as an invited chapter in *Numerical Solution of Partial Differential Equations on Parallel Computers*, A. M. Bruaset, P. Bjorstad, and A. Tveito, editors, Springer.

[4] P. Hovland, B. Norris, and B. Smith. Making automatic differentiation truly automatic: Coupling PETSc with ADIC. *Future Generation Computer Systems* 21(8):1426–1438, 2005.

[5] B. Norris and P. Hovland. A distributed application server for automatic differentiation. *INFORMATION* 6(3):305–314, July 2003.

[6] C. Bischof, P. Hovland, and B. Norris. Implementation of automatic differentiation tools. *Proceedings of the 2002 ACM SIGPLAN Workshop on Partial Evaluation and Semantics-Based Program Manipulation (PEPM-02)*, vol. 37, pp. 98–107. ACM Press, ACM SIGPLAN Notices 3, Jan. 14–15 2002. Substantially revised version to appear in a special issue of Higher-Order and Symbolic Computation, Springer.

[7] S. Bhowmick, P. Raghavan, L. C. McInnes, and B. Norris. Faster PDE-based simulations using robust composite linear solvers. *Future Generation Computer Systems* 20(3):373–387, 2004.

[8] B. Norris, S. Balay, S. Benson, L. Freitag, P. Hovland, L. McInnes, and B. Smith. Parallel components for PDEs and optimization: Some issues and experiences. *Parallel Computing* 28(12):1811–1831, 2002.

[9] J. Abate, S. Benson, L. Grignon, P. Hovland, L. McInnes, and B. Norris. Integrating automatic differentiation with object-oriented toolkits for high-performance scientific computing. *Automatic Differentiation of Algorithms: From Simulation to Optimization*, chapter 20, pp. 173–178. Springer, 2002. Proceedings of AD2000.

[10] A. Radenski, A. Vann, and B. Norris. Parallel probabilistic computations on a cluster of workstations. *Parallel Computing: Fundamentals, Applications, and New Directions*. Elsevier, 1998.

Refereed Conference Proceedings

[11] S. Akioka, K. Malkowski, P. Raghavan, M. J. Erwin, L. C. McInnes, and B. Norris. Characterizing the performance and energy attributes of scientific simulations. *Computational Science ICCS 2006: 6th International Conference, Reading, UK, May 28-31, 2006, Proceedings, Part I*, vol. 3991, pp. 242–249. Springer Berlin / Heidelberg, Lecture Notes in Computer Science, 2006, http://dx.doi.org/10.1007/11758501_36.

[12] S. Bhowmick, D. Kaushik, L. McInnes, B. Norris, and P. Raghavan. Parallel adaptive solvers in compressible PETSc-FUN3D simulations. *Proceedings of the 17th International Conference on Parallel Computational Fluid Dynamics, University of Maryland, College Park, MD, May 24–27*, 2006. to appear.

[13] B. Norris, L. McInnes, and I. Veljkovic. Computational quality of service in parallel CFD. *Proceedings of the 17th International Conference on Parallel Computational Fluid Dynamics, University of Maryland, College Park, MD, May 24–27*, 2006. to appear.

[14] B. Norris. Software architecture approaches for adaptive scientific computing. *Applied Parallel Computing: 7th International Conference, PARA 2004, Lyngby, Denmark, June 20-23, 2004. Revised Selected Papers*, vol. 3732, pp. 629–636. Springer Berlin / Heidelberg, Lecture Notes in Computer Science, 2006, http://dx.doi.org/10.1007/11558958_75.

[15] P. H. abd B. Norris, M. Strout, S. Bhowmick, and J. Utke. Sensitivity analysis and design optimiziation through automatic differentiation. *SciDAC 2005*, vol. 16, pp. 466–470. Institute of Phsysics Publishing, Journal of Physics: Conference Series, 2005, http://www.iop.org/EJ/article/1742-6596/16/1/063/jpconf5_16_063.pdf.

[16] P. Raghavan, M. J. Irwin, L. C. McInnes, and B. Norris. Adaptive software for scientific computing: Co-managing quality-performance-power tradeoffs. *Proceedings of the IEEE International Parallel & Distributed Processing Symposium 2005 (CDROM)*. IEEE Computer Society Press, 2005, http://doi.ieeecomputersociety.org/10.1109/IPDPS.2005.83.

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[18] B. Norris, J. Ray, R. C. Armstrong, L. C. McInnes, D. E. Bernholdt, W. R. Elwasif, A. D. Malony, and S. Shende. Computational quality of service for scientific components. *Proceedings of the International Symposium on Component-Based Software Engineering (CBSE7), Edinburgh, Scotland, May 24–25, 2004*, vol. 3054, pp. 264–271. Springer, Lecture Notes in Computer Science, 2004.

[19] J. W. Larson, B. Norris, E. T. Ong, D. E. Bernholdt, J. B. Drake, W. R. Elwasif, M. W. Ham, C. E. Rasmussen, G. Kumfert, D. S. Katz, S. Zhou, C. DeLuca, and N. S. Collins. Components, the common component architecture, and the climate/weather/ocean community. *Proceedings of 20th International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology*. AMS, http://www.amstoc.org.

[20] S. Bhowmick, L. C. McInnes, B. Norris, and P. Raghavan. The role of multi-method linear solvers in PDE-based simulations. *Computational Science and Its Applications - ICCSA 2003, Part I*, vol. 2667, pp. 828–839. Springer, 2003.

[21] P. Hovland, K. Keahey, L. C. McInnes, B. Norris, L. F. Diachin, and P. Raghavan. A quality of service approach for high-performance numerical components. *Proceedings of Workshop on QoS in Component-Based Software Engineering, Software Technologies Conference*, 20 June 2003.

[22] L. McInnes, B. Norris, S. Bhowmick, and P. Raghavan. Adaptive sparse linear solvers for implicit CFD using Newton-Krylov algorithms. *Proceedings of the Second MIT Conference on Computational Fluid and Solid Mechanics, Massachusetts Institute of Technology, Boston, USA, June 17-20, 2003*, pp. 1024–1028. Elsevier.

[23] P. D. Hovland, U. Naumann, and B. Norris. An XML-based platform for semantic transformation of numerical programs. *Proceedings of Software Engineering and Applications, November 4-6, 2002 Cambridge, MA*, pp. 530–538. ACTA Press, Nov. 02 2002, `ftp://info.mcs.anl.gov/pub/tech_reports/reports/P950.pdf`. Argonne National Laboratory preprint ANL/MCS-P950-0402.

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[26] P. Hovland, S. Lee, L. McInnes, B. Norris, and B. Smith. Challenges and opportunities in using automatic differentiation with object-oriented toolkits for scientific computing. *1st Sandia Workshop on Large-Scale PDE-Constrained Optimization, Santa Fe, NM, April 4 – 6, 2001*, Apr. 2001, `http://www.llnl.gov/tid/lof/documents/pdf/244369.pdf`.

[27] A. Radenski and B. Norris. Generic cluster-computing algorithms and applications. *Proceedings of the International Conference on Parallel and Distributed Processing Techniques and Applications, PDPTA 2000, June 24-29, 2000, Las Vegas, Nevada, USA*. CSREA Press, 2000.

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[30] P. Hovland, B. Norris, L. Roh, and B. Smith. Developing a derivative-enhanced object-oriented toolkit for scientific computations. *Object Oriented Methods for Interoperable Scientific and Engineering Computing: Proceedings of the 1998 SIAM Workshop*, pp. 129–137. SIAM, Mar. 1999, `ftp://info.mcs.anl.gov/pub/tech_reports/reports/P731.ps.Z`.

[31] A. Radenski, A. Vann, and B. Norris. Development and utilization of generic algorithms for scientific computations. *Object Oriented Technology: Proceedings of ECOOP 98, Workshop on Parallel Object Oriented Scientific Computing, Brussels, Belgium, July 20-24, 1998*, vol. 1543, pp. 464–465. Springer, Lecture Notes in Computer Science, 1998.

[32] A. Radenski, A. Vann, and B. Norris. Parallel probabilistic computations on a cluster of workstations. *Parallel Computing: Fundamentals, Applications and New Directions, Proceedings of the Conference ParCo'97, 19-22 September 1997, Bonn, Germany*, vol. 12, pp. 105–112. Elsevier, North-Holland, Advances in Parallel Computing, Feb. 1998.

Other Publications

[33] S. Akioka, K. Malkowski, P. Raghavan, M. J. Irwin, L. C. McInnes, and B. Norris. A characterization of power-aware high performance scientific simulations, 2006. in preparation.

[34] Z. Meglicki, S. K. Gray, and B. Norris. Multigrid FDTD with Chombo, 2006. under review.

[35] L. C. McInnes, J. Ray, R. Armstrong, T. L. Dahlgren, A. Malony, B. Norris, S. Shende, J. P. Kenny, and J. Steensland. Computational quality of service for scientific CCA applications: Composition, substitution, and reconfiguration. Tech. Rep. ANL/MCS-P1326-0206, Argonne National Laboratory, Feb. 2006, `ftp://info.mcs.anl.gov/pub/tech_reports/reports/P1326.pdf`.

[36] B. Norris and I. Veljkovic. Performance monitoring and analysis components in adaptive PDE-based simulations. Tech. Rep. ANL/MCS-P1221-0105, Argonne National Laboratory, Jan. 2005, `ftp://info.mcs.anl.gov/pub/tech_reports/reports/P1221.pdf`.

[37] B. Norris and P. D. Hovland. Users' guide to ADIC 1.1. Tech. rep., Argonne National Laboratory, Sept. 17 2002, `ftp://info.mcs.anl.gov/pub/tech_reports/reports/TM225.ps.Z`.

[38] B. Norris. *An Environment For Interactive Parallel Numerical Computing*. Ph.D. thesis, University of Illinois at Urbana-Champaign, Jan. 2000, `http://citeseer.ist.psu.edu/408665.html; http://www-unix.mcs.anl.gov/~norris/pubs/thesis.ps.Z`.

INVITED PRESENTATIONS

- "Performance Annotations on the BlueGene/L," SIAM PP'06 minisymposium on Application Performance Analysis and Optimization on BlueGene/L, February 22, 2006.
- "Enabling Technologies for Computational Science: Automatic Differentiation, Component Software, and Performance," EECE Colloquium, Marquette University, March 15, 2005.
- "Software Architecture Approaches for Adaptive Scientific Computing," PARA'04 minisymposium on Advanced Algorithms and Software for Scientific Computing, June 21, 2004.
- "Issues and Approaches in Scientific Component Software Development," Colloquium, Penn State University Computer Science and Engineering, March 18, 2004.
- "High-Performance Scientific Components," First Friday Forum, Argonne National Laboratory, June 2003.
- Panel member at the Women in Science Careers Conference, Argonne National Laboratory, March 2003.
- "CCA Components for Linear System Solution," SIAM Annual Meeting, minisymposium on New Approaches for Scalable Sparse Linear System Solution, July 10, 2002, Philadelphia.

TUTORIALS AND CONTRIBUTED PRESENTATIONS

- Common Component Architecture (CCA) Tutorials: SC'05, HPC2005, SC'04, SIAM PP'04, SC'03, and at some quarterly CCA meetings. Developed hands-on code and reusable build system.
- "Tools and Methods for Performance Modeling and Prediction," SIGMETRICS'04 Tutorial, New York, June 13, 2004.
- Common Component Architecture Forum presentations on various topics at most quarterly meetings since 2002.

- "Automatic Differentiation," MCS Summer Lecture Series, June 14, 2005.
- "Computational Quality of Service in Parallel CFD," PCFD'05, University of Maryland, College Park, May 26, 2005
- "ADIC 2.0 Status and Plans," Workshop on Automatic Differentiation, Nice, France, April 15, 2005.
- "Performance Evaluation Challenges and Adaptive Numerical Approaches," SIAM CSE Conference, Orlando, February 13, 2005.
- "Large-Scale Simulation of Plasmonic Nanodevices," Argonne LDRD proposal presentation, with Stephen Gray (Chemistry), September 24, 2004.
- "Multimethod Linear Solvers in PDE-Based Simulations," Computational Institute Brown Bag Lunch, University of Chicago, April 29, 2004.
- "Overview of the Common Component Architecture," Minisymposium on High-Performance Component Technologies, SIAM PP'04, San Francisco, February 25, 2004.
- "Adaptive Sparse Linear Solvers of Implicit CFD Using Newton-Krylov Algorithms," Second M.I.T. Conference on Computational Fluid and Solid Mechanics, Boston, June 2003.
- "A Distributed Application Server for Automatic Differentiation," 15th International Parallel & Distributed Processing Symposium, San Francisco, April 2001.
- "Automatic Differentiation: A Tool for Computational Science," Optimization Technology Center Seminar, Argonne National Laboratory and Northwestern University, October 2001.
- "Remote Access to Mathematical Software," IAMC'01, July 22, 2001, London, Canada.
- "An Interactive Problem-Solving Environment for Parallel Scientific Computations," First SIAM Conference on Computational Science and Engineering, September 2000, Washington, DC.

SELECTED SOFTWARE

- ADIC, source transformation automatic differentiation of ANSI C and C++ programs (`http://www.mcs.anl.gov/adic`). ADIC implements a technique for automatically transforming a computer code implementing an arbitrary mathematical function into another code that computes the function and its derivatives without incurring truncation error and often resulting in better performance than numerical approximation approaches, such as finite differences. Over the past five years, ADIC has been downloaded over 500 times and has been used in numerical optimization, sensitivity analysis, climate modeling, computational fluid dynamics, and other application areas.
- XAIF, an XML-based abstract intermediate representation for mathematical computations (`http://www.mcs.anl.gov/xaif`). The XAIF format enables clear separation between language-specific parser and analysis engines, which are typically very difficult to develop, and differentiation algorithms, which are intrinsically language-independent and can be implemented as graph transformations. XAIF is used in ADIC and the language-independent differentiation modules and Fortran AD tool being developed as part of the multi-institution OpenAD project.

- ADIC Web-based and command line remote application servers (`http://www.mcs.anl.gov/adicserver`) for access to ADIC 1.2 and 2.0 without having to install the tools on a user's machine.
- CCA scientific components; CCA middleware infrastructure and automated build system support (see tutorial source code at `http://www.cca-forum.org/tutorials`); Eclipse-based IDE support for scientific component development (see Usability at `http://cca-forum.org/wiki`); CCA-compliant linear algebra and optimization components. Numerical components have been used in scientific applications, such as molecular geometry optimization and computational fluid dynamics.
- Multimethod parallel linear solvers: combining or adaptively applying existing iterative algorithms to produce multimethod heuristics that result in improved robustness and performance. The prototype implementations are designed to feed into linear solver components and numerical toolkits, such as PETSc.
- Static performance modeling tools: estimate the number of floating-point operations and memory accesses through source code analysis (C and C++), and provide upper bounds on the performance of an application (`http://www.mcs.anl.gov/performance`).
- Structured block adaptive mesh refinement in finite-diference time-domain methods for nanophotonics simulations, whose goal is to learn how to control light on the nanoscale, for example, to replace electrons as information carriers in optical or opto-electronic devices, or to create novel chemical and biological sensors (`https://wiki.mcs.anl.gov/NanophotonicsWiki`).

REFERENCES

References are available upon request.